

RETROSPECTIVE IMMUNIZATION COVERAGE SURVEY

2005- 2006 Results (School Year 2009-10)



**Elizabeth M. Lawlor, MS
Kansas Department of Health and Environment
Division of Health
Bureau of Surveillance and Epidemiology
1000 SW Jackson, Suite 210
Topeka, Kansas 66612-1290
Telephone (785) 296-1059
Fax (785) 291-3775**

ACRONYMS

CI	Confidence interval
KCI	Kansas Certificate of Immunizations

VACCINE ACRONYMS

Vaccine acronym followed by a number indicates the number of doses.

4-3-1-3-3	Combination of DTaP4-Polio3-MMR1-Hib3-HepB3
4-3-1	Combination of DTaP4-Polio3-MMR1
DTaP	Diphtheria and tetanus toxoids and acellular pertussis vaccines including diphtheria and tetanus toxoids (DTaP/DT) vaccine
HepB	Hepatitis B vaccine
Hib	<i>Haemophilus influenzae</i> type b vaccine
MMR	Measles, mumps, and rubella vaccine
PCV	Pneumococcal conjugate vaccine
Polio3	Polio vaccine
Var	Varicella vaccine

EXECUTIVE SUMMARY

Overview

The Kansas Certificates of Immunizations (KCI) and other immunization data for children enrolled in a kindergarten class in Kansas public and private schools during the 2009-2010 school year were collected and evaluated for immunization coverage rates. Children born between September 2, 2003 and September 1, 2004 were included in this study, and their immunization coverage rates at 24 months of age, i.e., between September 2, 2005 and September 1, 2006, were analyzed. The results for this survey were measured against similar previous studies. In total, there were 797 schools, 695 public and 102 private, included in the analysis. A representative sample of 15,330 children from both public and private schools with complete and usable KCIs, or other sources of immunization data, were included in the analysis.

Coverage at 24 Months of Age

The statewide coverage rate for the 4-3-1-3-3 series (DTaP4, Polio3, MMR1, Hib3, HepB3) for children by 24 months of age increased, compared to 2004-2005, by more than 6.5 percentage points to 70%, which was below the Healthy People 2010 goal of at least 80%. Varicella vaccination, which has been required for school entry since the 2005-06 school year, had a coverage rate of 85% by 24 months of age. The coverage rates for PCV3, which is not required for school entry, increased by more than 13 percentage points to 70%.

The 105 counties were grouped into 3 categories based on population density, and coverage rates were compared among these groups. Counties that were “sparsely populated” (<20 persons per square mile) had higher coverage rates for the 4-3-1-3-3 series than “moderately populated” (20 – 149.9 persons per square mile) and “urban” (≥150 persons per square mile) counties. Of the 42 counties that reached the Healthy People 2010 goal for the 4-3-1-3-3 series, 39 were sparsely populated (Appendix 3). At least 73 counties had 90% coverage or better for Polio3, MMR1, HepB3, and Hib3. Only 21 counties had DTaP4 coverage rates of at least 90%.

Trends

Immunization coverage rates of children by 24 months of age increased each year from 1990-91 through 2000-01 and remained elevated for most single vaccines. Significant decreases in rates for DTaP4 and the 4-3-1-3-3 series occurred in 2001-02 due to a shortage of the DTaP vaccine. The coverage rate for the 4-3-1-3-3 series has been increasing following the reduction in coverage, and the 4-3-1-3-3 and DTaP4 coverage rates are no longer significantly different than the 2000-01 rates. Beginning in 2003-04 and continuing through 2005-06 (2009-10 Retrospective Study), the rates for most vaccinations have been increasing. Continued assessment and evaluation of immunization rates are necessary to monitor progress toward the Healthy Kansas 2010 goal of 90% immunization coverage, which will aid in increasing herd immunity, thus reducing disease incidence and limiting outbreaks.

RETROSPECTIVE IMMUNIZATION COVERAGE SURVEY 2005-2006 (SCHOOL YEAR 2009-2010)

INTRODUCTION

Objective

This study was conducted to estimate the immunization coverage rates of children at 24 months of age.

Study Population

The study population included all kindergarten students enrolled in both public and private schools in the 2009-10 school year.

Study Design

A stratified, cross-sectional design was utilized for this study, with each county representing a stratum. The characteristics of interest, or outcome variables, were the percentages of children who were fully immunized against diphtheria, tetanus, pertussis, polio, measles, mumps, rubella, *H. influenzae* type b, hepatitis B virus, varicella, and pneumococcal disease. Coverage rates were assessed for these children at 24 months of age.

Immunization coverage rates were measured for single vaccines and combinations of vaccines according to the recommended immunization schedule for children by 24 months of age.¹ The schedule for 2004 is in Appendix 4. *The results of the survey refer to children who were born between September 2, 2003, and September 1, 2004. The coverage rates refer to the point in time at which these children turned 24 months old, between September 2, 2005 and September 1, 2006.*

METHODS

Sampling Techniques

A probability sample of all children enrolled in Kansas public school kindergartens was drawn. To ensure an adequate sample size in each county and to maximize the efficiency of the sampling process, a different sampling ratio was established for each county, and a probability sample was selected using a systematic sample technique.² Due to the small size of the private school population in Kansas, all records from private schools were solicited.

Data Collection

All Kansas public and private schools with a kindergarten class received a letter, co-signed by officials representing the Kansas Department of Health and Environment (KDHE) and the Kansas State Department of Education (KSDE), requesting their participation in the survey. The letters sent to public schools specified the number of records required to generate estimates of county-specific coverage rates (i.e., sample size) and outlined the process of systematically selecting a probability sample of records.

¹ The Recommended Immunization Schedule used, as reference for ages and immunization in this paper was the schedule approved by the Advisory Committee on Immunization Practices (ACIP), the American Academy of Pediatrics (AAP) and the American Academy of Family Physicians (AAFP) for the year 2004.

² The sample ratio was the ratio between the total enrollment in a school and the sample size, and it represents the proportion of enrolled children who are sampled.

Depending on the calculated sampling ratio for their county, the study coordinator at each school (typically the school nurse) was instructed to select all, every other, every third, every sixth, every eighteenth, or every nineteenth immunization record regardless of the size of the kindergarten class at that school. The private schools were instructed to select all immunization records. The schools were informed they could submit KCIs or any other form of immunization record, including printouts from computerized record keeping programs. The study coordinators were also advised to remove all personal identifiers, except date of birth, to ensure confidentiality. Copies of the immunization records and the current total number of kindergarten enrollees in each school were forwarded to KDHE.

Data Analysis

Starting in the 2006-07 Retrospective Survey and continuing through the 2009-10 survey, the data analysis methods were changed from previous years. In the current study, all children who had a date of birth recorded on the Kansas Certificate of Immunizations (KCI) or other data source and were the appropriate age for the analysis were included in the denominator. Point estimates of coverage rates and 95% confidence intervals (95% CI) for DTaP4, Polio3, MMR1, Hib3, HepB3, 4-3-1-3-3 combination, Var1, and PCV3 vaccines were calculated. A child was considered “up-to-date” for single vaccines if, at 24 months of age, he or she had received at least four doses of DTaP (DTaP4), three doses of polio (Polio3), one dose of measles, mumps, and rubella (MMR1), three doses of *H. influenzae* type b (Hib3), three doses of hepatitis B (HepB3), one dose of varicella (Var1) vaccine, and three doses of pneumococcal conjugate (PCV3). A child was considered “up-to-date” for the 4-3-1-3-3 series if he or she was up-to-date for DTaP4, Polio3, MMR1, Hib3, and HepB3 vaccines. All children who indicated history of varicella were included in the denominator, but only those who reported history of vaccination were included in the numerator. This methodology was performed because the date of disease was frequently not recorded, thus it could not be determined if the child had the disease before two years of age. Analyses were performed using weighted data, and the analyses accounted for the complex sample design effect due to the stratification process and differences in sampling ratios between counties.³ Sample weights were calculated using the number of kindergartners enrolled in a county and the number of records analyzed for that county.

The 105 counties were categorized based on population densities calculated from the 2004 Annual Summary of Vital Statistics.⁴ The 2004 Annual Summary of Vital Statistics data correspond to the data in the current retrospective survey. For the purpose of this analysis, counties were grouped by population density into “urban,” “moderately populated,” and “sparsely populated” (Appendix 1). Immunization coverage rate estimates were compared among these groups.

RESULTS

Data Collection

Letters of invitation to participate in the survey were sent to 864 Kansas schools; of these, 747 were public schools and 117 were private. Fourteen schools reported not having a kindergarten class for the 2009-2010 school year and 51 did not respond. Data were received from 799 schools (697 public

³ Complex survey design effect was accounted for by using the SAS Procedure PROC SURVEYFREQ.

⁴ 2004 Annual Summary of Kansas Vital Statistics (<http://www.kdheks.gov/ches>)

schools and 102 private schools) with kindergarten classes, corresponding to a school participation rate of 94%.⁵

The number of children enrolled in kindergarten at the participating public and private schools was 37,882, which is 95.8% of the 39,553 children in that birth cohort.⁶ The children in the birth cohort that did not participate in the study include children who attend home school or other special schools as well as those enrolled in schools that did not participate in the study. The number of immunization records received was 15,645. This is equivalent to a sampling ratio of 2.4, meaning that one child was selected for every 2.4 children enrolled. The range of the sample size by county was from 14 to 1,102 records while the range of student enrollment was from 14 to 7,836.⁷

Of the 15,645 immunization records returned and examined, 15,330 (98%) were complete and had usable information regarding birth dates and immunization history. The majority of the immunization records submitted by schools were KCIs; however, some schools submitted printouts from computerized record keeping programs. For the 24 month old analysis, 13,563 (88%) children were included in the analysis because they were 24 months of age between September 2, 2005 and September 1, 2006. In the weighted analysis, 0.1% of the study population did not have vaccinations because of a medical exemption and 1% did not have vaccinations because of a religious exemption.

The number of records examined by population density includes: 3,724 (27.5% of all records used, representing 11.1% of the population after weighting) in sparsely populated, 6,361 (46.9% of all records used, representing 32.2% of the population after weighting) in moderately populated, and 3,478 (25.6% of all records used, representing 56.7% of the population after weighting) in urban counties. The birth cohort across the state of Kansas is 10.7% sparsely populated, 34.6% moderately populated and 54.6% urban.⁸

Statewide Immunization Coverage by Age 24 Months

The immunization coverage rates for several of the single vaccines significantly changed compared to coverage rates from the previous year. Hib3, HepB3, Var1, and PCV3 coverage rates increased significantly from last year, while DTaP4, Polio3, and MMR1 coverage rates remained unchanged. The immunization rate for 4-3-1-3-3 was 69.7%, which was significantly greater than last year's estimate (Table 1). Vaccine coverage rates for DTaP4 rose each year from 1990-91 through 2000-01, decreased significantly in 2001-02 and 2002-03, then increased significantly in 2003-04 and remained unchanged in 2004-05 and 2005-06 as displayed in Figure 1. The coverage rate for PCV3, which was measured for the fourth time, was 69.9% (Figure 2).

⁵ In total, there were 797 schools, 695 public and 102 private, included in the analysis; KCIs from 2 public schools could not be included in the analysis as the dates of birth were removed

⁶2004 Annual Summary of Kansas Vital Statistics (<http://www.kdheks.gov/ches>)

⁷ Estimates from counties with small sample size (<50) may be unstable and changes over time should be interpreted with caution

⁸ Numbers are rounded

TABLE 1 Immunization coverage rates at 24 months of age by vaccine, Kansas 2005-2006.

*Percentage up-to-date and 95% confidence interval

	Percent (%)	95% CI
DTaP4	81.0	79.8 - 82.2
Polio3	92.3	91.4 - 93.1
MMR1	91.6	90.8 - 92.4
Hib3	85.1	84 - 86.2
HepB3	92.7	91.9 - 93.6
4-3-1-3-3 Series	69.7	68.3 - 71.1
Var1	84.6	83.6 - 85.7
PCV3	69.9	68.5 - 71.3

* Based on retrospective survey from school year starting in 2009.

FIGURE 1 Immunization coverage rates at 24 months of age by vaccine, Kansas 1990 - 2005.*

* Based on retrospective surveys from school years starting in 1994 through 2009.

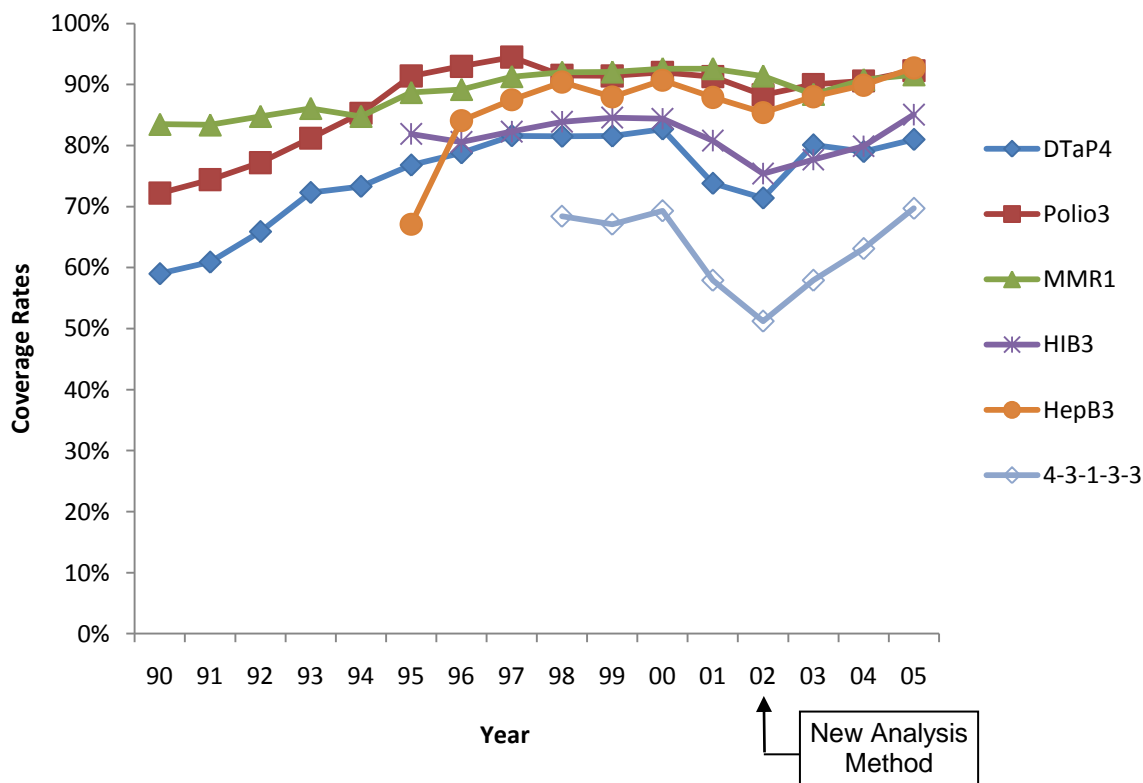
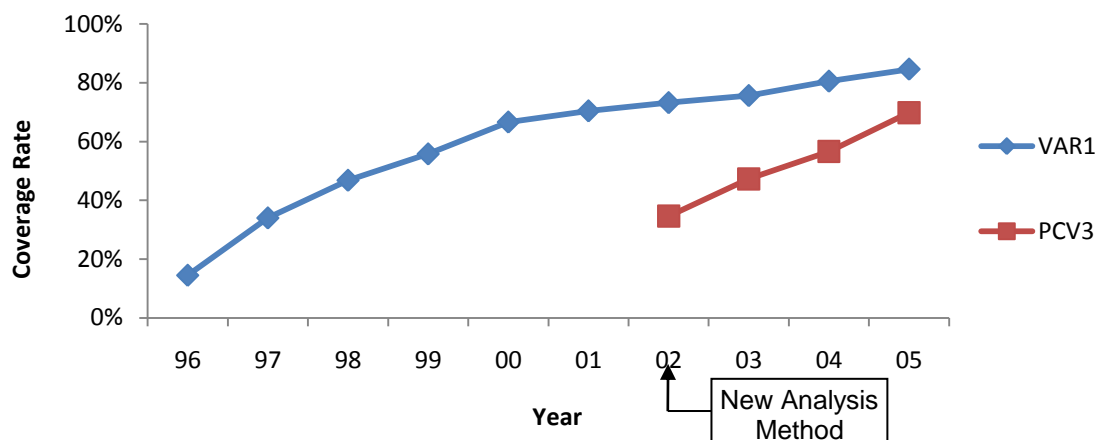


FIGURE 2 Immunization coverage rates at 24 months of age by vaccine, Kansas 1996 - 2005.*

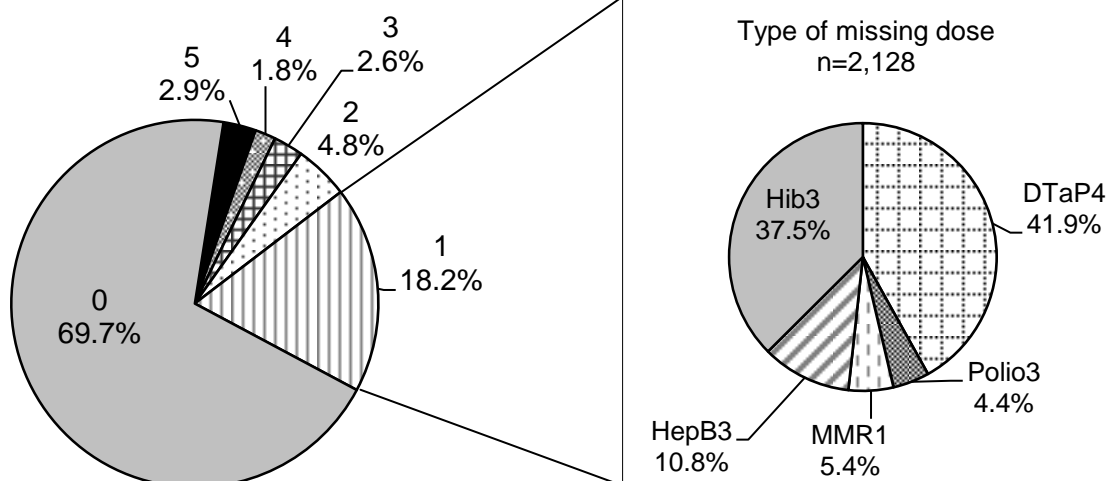


* Based on retrospective surveys from school years starting in 2000 through 2009.

Of children not up-to-date for 4-3-1-3-3 at 24 months of age, 60% (18% of total population studied) needed one additional immunization (Figure 3). If these children had received the missing vaccination, the coverage rates for the 4-3-1-3-3 series would have increased from 69.7% to 87.9%. Among children who needed one immunization, 37.5% needed Hib3 and 47.9% needed DTaP4 (Figure 3). Of children not up-to-date at 24 months of age, 9.5% (2.9% of total population studied) were not up-to-date on any of the vaccine series (DTaP4, Polio3, MMR1, HepB3 and Hib3). When children with either a medical or religious exemption were excluded from the analysis, 7.1% (2.7% of total population studied) were not up-to-date for any of the 5 vaccination series (DTaP4, Polio3, MMR1, HepB3, and Hib3).

FIGURE 3: Number and type of immunizations children at 24 months of age needed to be up-to-date for the 4-3-1-3-3, Kansas 2005 - 2006.*

**Number of immunizations needed
(% of children)
n=13,563**



*Based on the retrospective survey for the school year starting 2009.

In the state of Kansas, two legal alternatives to vaccination exist: medical exemption and religious exemption. To receive a medical exemption, a physician must sign a form stating the reason for exemption and from which vaccine(s) the child is exempt. A parent or guardian must write a statement explaining that the child is an adherent of a religious denomination whose religious teachings are opposed to such tests or inoculations to receive a religious exemption. During the 2009-10 retrospective study, 0.1% of the study population indicated a medical exemption, while 1% indicated a religious exemption to one or more vaccine. When all children who had a stated exemption to any vaccine were excluded from the analysis, there was no significant difference between immunization rates for any vaccine (Table 2).

TABLE 2 Kansas immunization coverage rates of all and non-exempt children at 24 months of age, Kansas 2005 - 2006.

	All 24 month olds n=13,563 % (95% CI)	Non-Exempt 24 month olds n=13,439 % (95% CI)
DTaP4	81 (79.8 - 82.2)	81.7 (80.5 - 82.8)
Polio3	92.3 (91.4 - 93.1)	93 (92.3 - 93.8)
MMR1	91.6 (90.8 - 92.4)	92.3 (91.6 - 93.1)
Hib3	85.1 (84 - 86.2)	85.8 (84.8 - 86.9)
HepB3	92.7 (91.9 - 93.6)	93.5 (92.7 - 94.3)
4-3-1-3-3 Series	69.7 (68.3 - 71.1)	70.4 (69 - 71.8)
Var1	84.6 (83.6 - 85.7)	85.4 (84.4 - 86.5)
PCV3	69.9 (68.5 - 71.3)	70.6 (69.2 - 71.9)

County-level Immunization Coverage of Children at 24 Months of Age

Immunization coverage was also analyzed at the county level. All vaccine coverage rates are displayed by county in Appendix 2.

Of the 105 counties, 42 reached the Healthy People goal of at least 80% coverage for the 4-3-1-3-3 series; 39 of the 42 counties were sparsely populated (Appendix 3). Twenty-one counties had 90% coverage or better for DTaP4; 94 and 86 counties had a minimum of 90% coverage for Polio3 and MMR1, respectively, while 99 counties had coverage rates of at least 90% for HepB3. Twenty-seven counties had coverage of 90% or better for Var1. Geographic regions with low immunization rates for DTaP4 and MMR1 were in the southeast corner of the state. Those counties with less than 80% coverage for 4-3-1-3-3 were primarily in the eastern half of the state.

Counties were classified based on their population densities, and coverage rates were compared among the three categories (Table 3). Counties that were sparsely populated had significantly higher coverage rates for the 4-3-1-3-3 series than counties with greater population densities (moderately populated, urban).

TABLE 3 Kansas immunization coverage rates by peer group for 2005-2006.*

Counties by Population Density – Condensed Groups n=13,422			
	Sparsely Populated n=3,569 (95% CI)	Moderately Populated n=6,213 (95% CI)	Urban n=3,640 (95% CI)
DTaP4	83.4 (82.2 - 84.6)	80.4 (79.3 - 81.4)	80.9 (78.9 - 82.8)
Polio3	94.5 (93.8 - 95.3)	93.2 (92.5 - 93.8)	91.3 (89.9 - 92.7)
MMR1	92.7 (91.9 - 93.6)	91.6 (90.8 - 92.3)	91.4 (90 - 92.8)
Hib3	92.4 (91.6 - 93.3)	86.2 (85.3 - 87.1)	83 (81.1 - 84.8)
HepB3	95.2 (94.5 - 95.9)	94.2 (93.5 - 94.8)	91.4 (90 - 92.9)
4-3-1-3-3 Series	78.8 (77.5 - 80.1)	71 (69.8 - 72.2)	67.2 (64.8 - 69.5)
Var1	84.5 (83.3 - 85.6)	83.7 (82.7 - 84.6)	85.2 (83.4 - 87)
PCV3	71.6 (70.2 - 73.1)	68.6 (67.4 - 69.9)	70.2 (67.9 - 72.6)

* Based on retrospective surveys from school years starting in 2009

DISCUSSION

Statewide immunization coverage rates by 24 months of age statistically increased from last year for most vaccines (Hib3, HepB3, Var1, and PCV3) in the current 2009-2010 Retrospective Survey. Polio3, MMR1, and HepB3 were the only vaccinations that met the Healthy People 2010 goal of at least 90% coverage. The coverage rates for DTaP4, Hib3, and Var1 were less than 9 percentage points from meeting this goal.⁹ The 4-3-1-3-3 series remains more than 10 percentage points from meeting the goal of 80% coverage. However, if the children missing only one vaccination in the 4-3-1-3-3 series received the needed immunization, the goal would be exceeded (87.9%). Since 2002-2003, Var1 and PCV3 have significantly increased each year. Immunization against *H. influenzae* type B and PCV3 was not required for school entry for the 2009-2010 school year, and thus not always recorded in school immunization records. For this reason, the immunization coverage rates might actually be higher than those represented in the data.

Forty-two counties (representing 7.9% of the birth cohort) reached the Healthy People goal of at least 80% coverage for the 4-3-1-3-3 series. Thirty-nine of these counties were sparsely populated, while the remaining 3 counties were moderately populated (Appendix 3). For DTaP4, 21 counties (representing 3.7% of the birth cohort) had at least 90% coverage, while 29 counties (representing 39.2% of the birth cohort) had less than 80% coverage for DTaP4. Ninety-nine counties (representing 77.1% of the birth cohort) had a minimum of 90% coverage for HepB3. Twenty-eight counties (representing 6.2% of the birth cohort) had 90% or greater coverage for Var1.

Geographic regions where immunization rates were high (90% or greater) for DTaP4 and Var1 were in the western part of the state. DTaP4 and Var1 coverage rates were lower in the southeast corner of the state. Coverage rates for 4-3-1-3-3 and Hib3 were lower in the eastern part of the state.

⁹Healthy People 2010 set goals of 90% coverage for DTaP4, Polio3, MMR1, Hib3, HepB3, and Var1 and 80% coverage for 4-3-1-3-3 series among children aged 19 to 35 months.

County designations were used to create categories by population. The coverage rate estimates were compared to determine if differences exist among the counties of different population densities. For the 4-3-1-3-3 series, the coverage rate of sparsely populated counties was statistically higher compared to moderately populated and urban counties, and the moderately populated rates were statistically greater than the urban rates. Additionally, the coverage rate estimate for the sparsely populated category, which only accounts for 11% of the population surveyed, compared to the coverage rate estimates of the other two categories (moderately populated, urban) was significantly higher for DTaP4, Polio3, MMR1, and Hib3. The moderately populated category, which is comprised of 32% of the population surveyed, had the lowest coverage estimates for Var1. The moderately populated counties did not have the highest coverage rate for any vaccine. Urban counties, which includes the most densely populated counties and represents 57% of the population surveyed, had the lowest coverage rate estimates for Polio3, Hib3, HepB3, and the 4-3-1-3-3 series. Var1 was the only vaccine for which the urban category had the highest rate. Due to the large percentage of the population living in the 5 urban counties (57%), targeting this population to improve vaccination coverage would increase the statewide immunization rates.

The results from this survey were compared with the results from the 2006 National Immunization Survey (NIS), which refers to the same time period as this retrospective survey.¹⁰ The results were compared to confirm the coverage rates in the retrospective survey and to compare immunization rates in Kansas to the rest of the US. Data for the population-based NIS are collected by the Centers for Disease Control and Prevention (CDC) through a telephone survey of randomly selected households. For accuracy, the healthcare providers of the children included in the survey are contacted by mail. The coverage rate for the 4-3-1-3-3 series is lower in the retrospective survey (69.7 [95% CI 68.3 – 71.1]) when compared to the NIS result (76.4 [95% CI 71.1 – 81.7]) for Kansas; however, the rates are not statistically different. Possible reasons for the difference in rates are that Hib3 is not required for school entry and may not be routinely recorded on school immunization records as well as differences in sampling methodologies.

Vaccine coverage is of great public health importance. By having greater vaccine coverage rates, there is an increase in herd immunity, which leads to lower incidence rates and an ability to limit the size of disease outbreaks. In 2006, a widespread outbreak of mumps occurred in Kansas and across the United States. Prior to the outbreak, the incidence rate of mumps was at a historical low, and even with the outbreak, the rates were still lower than pre-vaccination era. Due to high vaccine coverage rates, tens or hundreds of thousands of cases were possibly prevented.

Limitations

Limitations of this survey include: the survey reports data that refer to immunization coverage rates that occurred three years before the survey. Due to Hib3 and PCV3 not being required for school entry, these vaccines may not consistently be reported on the immunization record, thus decreasing coverage rates for the individual vaccines, as well as the 4-3-1-3-3 series. This is evident in Appendix 2 for several counties that have extremely low rates for the 4-3-1-3-3 series as well as low Hib3 and PCV3 coverage rates. Also, no descriptive data are collected about sex, race, or ethnicity. Additionally, it is possible the exemption data is not an accurate representation of exemptions among children due to the sampling method.

¹⁰ 2006 NIS Table Data (http://www.cdc.gov/vaccines/stats-surv/nis/data/tables_2006.htm)

Strengths

Despite the limitations, the retrospective immunization survey provides a good estimation of the early childhood immunization coverage rates for Kansas. It allows state and local officials to identify counties and regions with low vaccine coverage rates. Focus on these areas and implementation of enhanced vaccination delivery methods and educational campaigns can aid in Kansas achieving the 90% coverage rate goal. To aid in this goal, a similar survey is planned for next year.

Appendix 1: Kansas counties categorized based on population density, 2000.

**Sparsely
Populated**

Anderson
Barber
Brown
Chase
Chautauqua
Cheyenne
Clark
Clay
Cloud
Coffey
Comanche
Decatur
Edwards
Elk
Ellsworth
Gove
Graham
Grant
Gray
Greeley
Greenwood
Hamilton
Harper
Haskell
Hodgeman
Jackson
Jewell
Kearny
Kingman
Kiowa
Lane
Lincoln
Linn
Logan

Marion
Marshall
Morris
Morton
Nemaha
Ness
Norton
Osborne
Ottawa
Pawnee
Phillips
Pratt
Rawlins
Republic
Rice
Rooks
Rush
Russell
Scott
Sheridan
Sherman
Sherman
Smith
Stafford
Stanton
Stevens
Thomas
Trego
Wabaunsee
Wallace
Washington
Wichita
Wilson
Woodson

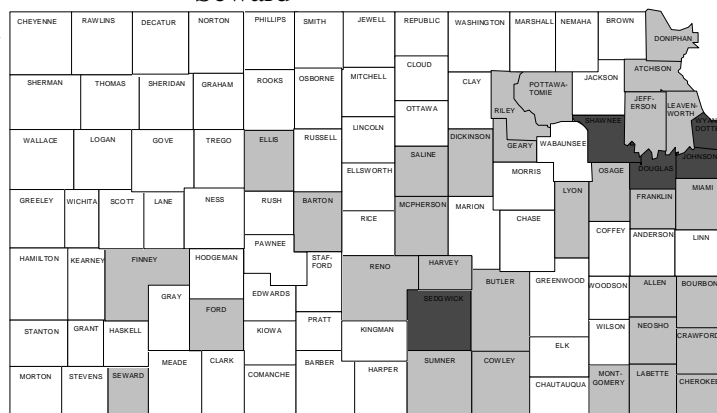
**Moderately
Populated**

Allen
Atchison
Barton
Bourbon
Butler
Cherokee
Cowley
Crawford
Dickinson
Doniphan
Ellis
Finney
Ford
Franklin
Geary
Harvey
Jefferson
Labette
Leavenworth
Lyon
McPherson
Miami
Montgomery
Neosho
Osage
Pottawatomie
Reno
Riley
Saline
Seward

Urban

Douglas
Johnson
Sedgwick
Shawnee
Wyandotte

Persons per Square Mile in Peer Groups
Sparsely Populated = <6 – 19.9
Moderately Populated = 20 – 149.9
Urban = ≥ 150.0



□ Sparsely Populated ■ Moderately Populated ■ Urban

APPENDIX 2: Immunization Coverage Rates of Children 24 Months of Age for Kansas Counties
2009-2010 (percentages).*§

COUNTY	DTaP4	Polio3	MMR1	Hib3	HepB3	4-3-1-3-3	4-3-1	Var1	PCV3
STATEWIDE	81	92	92	85	93	70	79	85	70
ALLEN	78	93	91	88	95	71	77	85	66
ANDERSON	75	90	85	83	91	64	73	77	74
ATCHISON	87	96	93	94	95	83	86	74	30
BARBER	84	95	92	92	97	82	84	79	68
BARTON	80	91	90	76	91	68	80	85	60
BOURBON	83	92	92	94	92	77	80	74	81
BROWN	81	97	97	96	98	79	80	66	68
BUTLER	82	94	89	94	95	78	80	77	73
CHASE	72	92	96	88	96	64	64	60	0
CHAUTAUQUA	72	86	88	91	91	67	67	81	77
CHEROKEE	75	92	92	87	92	70	75	89	85
CHEYENNE	73	100	95	100	100	68	68	86	91
CLARK	92	96	96	96	100	84	84	88	96
CLAY	80	95	94	96	97	77	78	89	86
CLOUD	83	93	93	92	95	79	80	91	84
COFFEY	85	93	92	92	93	85	85	84	80
COMANCHE	92	100	100	100	100	92	92	92	77
COWLEY	78	94	93	93	95	74	77	81	63
CRAWFORD	76	92	90	92	95	69	73	71	60
DECATUR	83	83	83	83	83	83	83	78	56
DICKINSON	92	97	94	96	95	88	89	86	87
DONIPHAN	81	93	85	86	92	74	76	78	74
DOUGLAS	80	90	91	84	86	65	76	87	68
EDWARDS	88	100	100	100	100	88	88	97	97
ELK	75	94	84	97	97	66	66	84	75
ELLIS	93	95	97	80	99	74	91	93	70
ELLSWORTH	79	97	95	97	98	77	79	90	82
FINNEY	80	93	90	90	92	75	79	88	82
FORD	83	94	92	91	95	78	81	86	81
FRANKLIN	80	89	94	89	94	78	78	89	79
GEARY	77	92	89	83	93	66	74	89	67
GOVE	76	100	90	86	100	71	76	86	67
GRAHAM	85	95	90	90	100	80	80	90	40
GRANT	81	89	90	93	92	77	78	85	69
GRAY	88	96	95	92	98	87	88	90	83
GREELEY	92	100	92	100	100	85	85	92	100
GREENWOOD	78	95	88	86	94	68	74	79	71
HAMILTON	82	100	97	97	100	82	82	89	82
HARPER	80	90	95	90	88	73	78	90	67
HARVEY	86	95	94	68	95	62	84	81	55
HASKELL	80	95	88	97	97	80	80	85	75
HODGEMAN	82	88	100	88	100	82	82	82	82
JACKSON	86	94	92	83	94	71	84	80	61
JEFFERSON	85	96	91	91	97	78	81	85	87

COUNTY	DTaP4	Polio3	MMR1	Hib3	HepB3	4-3-1-3-3	4-3-1	Var1	PCV3
STATEWIDE	81	92	92	85	93	70	79	85	70
JEWELL	100	100	100	94	100	94	100	89	67
JOHNSON	85	92	94	79	88	65	83	88	68
KEARNY	88	98	93	93	95	80	83	88	83
KINGMAN	76	88	85	90	92	74	74	69	58
KIOWA	86	91	95	91	91	86	86	82	55
LABETTE	76	92	88	88	93	68	74	81	74
LANE	85	96	92	92	96	81	85	92	81
LEAVENWORTH	82	92	91	84	92	70	79	85	73
LINCOLN	82	89	89	92	95	79	79	87	53
LINN	76	94	91	93	93	71	75	75	61
LOGAN	95	95	95	100	100	95	95	68	82
LYON	85	95	93	93	96	81	84	78	41
MARION	85	92	90	91	93	77	82	75	64
MARSHALL	87	98	95	95	96	83	86	86	80
MCPHERSON	85	91	94	11	91	8	83	88	8
MEADE	87	100	84	84	100	68	77	87	84
MIAMI	78	91	90	88	92	74	77	82	74
MITCHELL	81	92	95	90	95	81	81	90	75
MONTGOMERY	74	89	92	85	91	68	72	84	46
MORRIS	67	89	87	86	89	60	65	71	48
MORTON	82	98	95	91	93	77	82	89	57
NEMAHA	83	96	94	95	96	80	82	77	67
NEOSHO	17	97	92	94	94	14	17	78	12
NESS	92	100	92	100	100	83	83	92	100
NORTON	89	96	100	91	98	89	89	93	58
OSAGE	81	92	94	90	94	77	78	85	87
OSBORNE	65	76	76	71	88	65	65	82	59
OTTAWA	91	95	93	93	99	87	89	92	88
PAWNEE	94	98	94	98	98	89	91	93	83
PHILLIPS	93	98	96	96	98	91	93	91	80
POTTAWATOMIE	84	97	91	92	94	78	81	81	84
PRATT	86	97	92	97	96	84	86	90	48
RAWLINS	75	100	88	88	100	75	75	88	94
RENO	83	95	91	92	96	73	78	88	90
REPUBLIC	88	98	98	95	100	85	88	90	88
RICE	80	91	90	91	93	74	76	82	66
RILEY	84	92	93	85	94	71	80	88	81
ROOKS	90	98	98	98	100	90	90	90	83
RUSH	92	96	96	92	96	88	92	92	80
RUSSELL	83	94	92	95	95	81	81	81	94
SALINE	84	93	93	89	96	77	81	90	87
SCOTT	96	98	96	96	98	91	93	89	80
SEDGWICK	79	91	91	90	95	73	76	83	72
SEWARD	76	93	90	91	97	74	76	81	74
SHAWNEE	80	93	91	90	94	73	79	85	84
SHERIDAN	90	100	95	95	90	70	85	95	60

COUNTY	DTaP4	Polio3	MMR1	Hib3	HepB3	4-3-1-3-3	4-3-1	Var1	PCV3
STATEWIDE	81	92	92	85	93	70	79	85	70
SHERMAN	81	92	91	91	92	80	80	83	84
SMITH	94	100	97	97	97	94	94	90	90
STAFFORD	84	96	96	87	93	76	80	93	58
STANTON	92	94	97	92	97	89	92	89	72
STEVENS	75	96	93	95	96	75	75	88	54
SUMNER	79	92	93	88	94	74	79	77	28
THOMAS	90	98	98	95	98	86	89	90	80
TREGO	88	94	88	94	100	88	88	81	75
WABAUNSEE	90	94	95	92	94	81	87	87	84
WALLACE	74	95	95	89	100	68	68	89	79
WASHINGTON	97	97	97	95	95	89	95	97	75
WICHITA	93	100	93	96	93	89	93	93	93
WILSON	77	97	95	96	95	75	77	84	47
WOODSON	86	93	86	97	93	79	79	86	62
WYANDOTTE	74	89	86	67	91	52	71	83	58

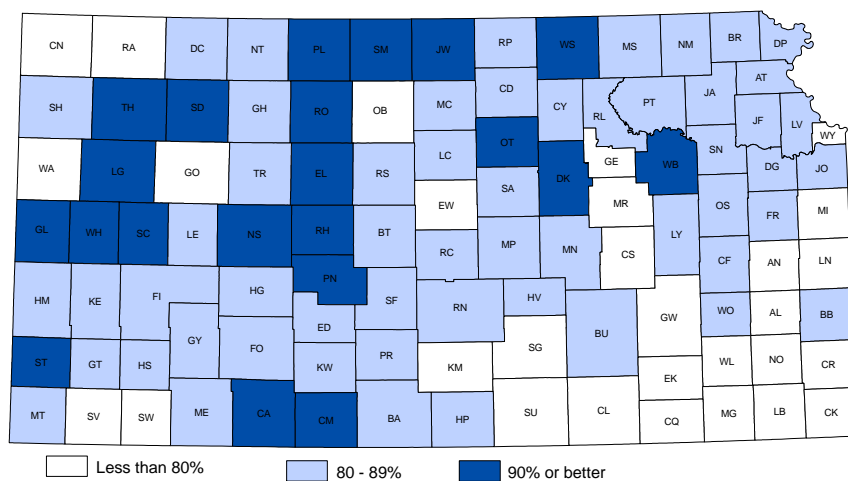
* Based on the retrospective survey for the school year starting 2009.

§ Due to Hib3 and PCV3 not being required for school entry, these vaccines may not consistently be reported on the immunization record, thus decreasing coverage rates for the individual vaccines, as well as the 4-3-1-3-3 series.

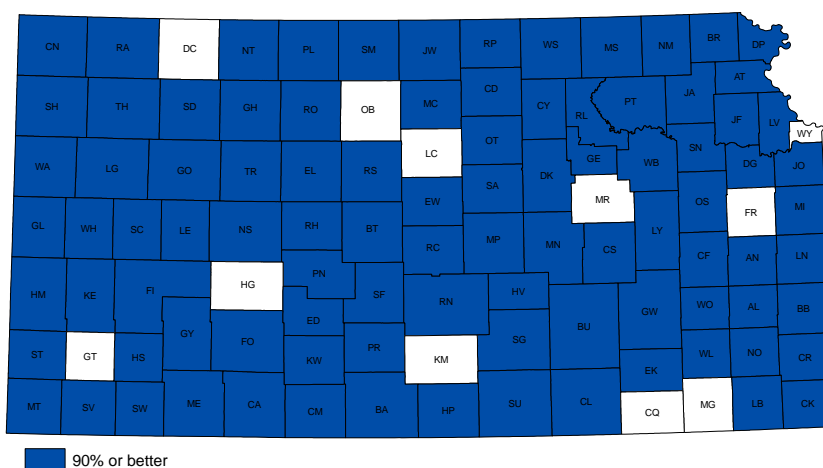
This is evident for several counties that have extremely low rates for the 4-3-1-3-3 series as well as low Hib3 and PCV3 coverage rates.

Appendix 3: Maps of immunization rates by county, 2009-10 Retrospective Survey.

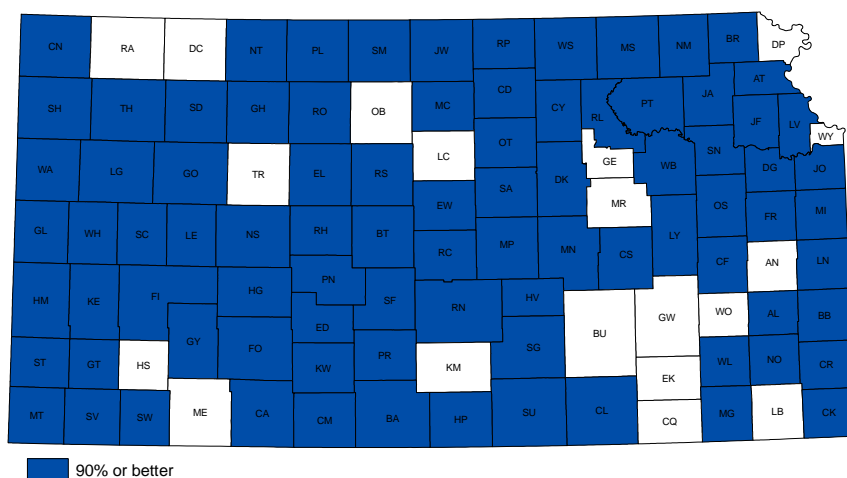
DTaP4 Series for Retrospective Survey 2009-10



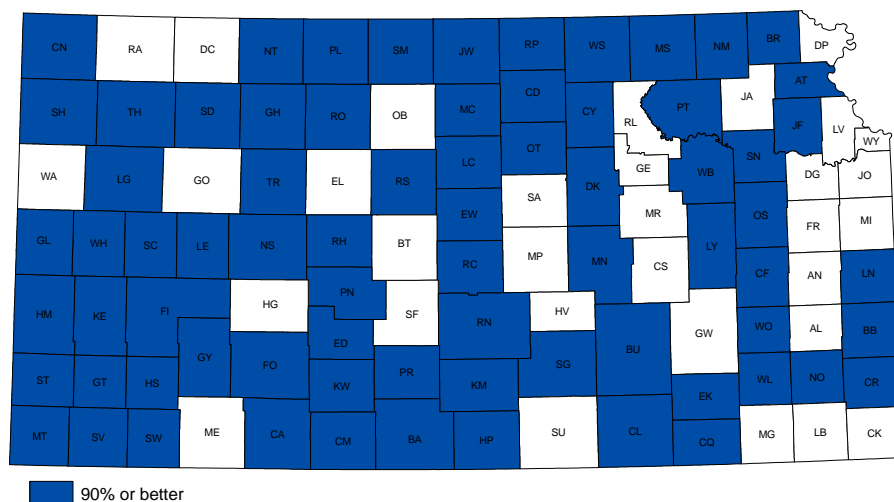
Polio3 Series for Retrospective Survey 2009-10



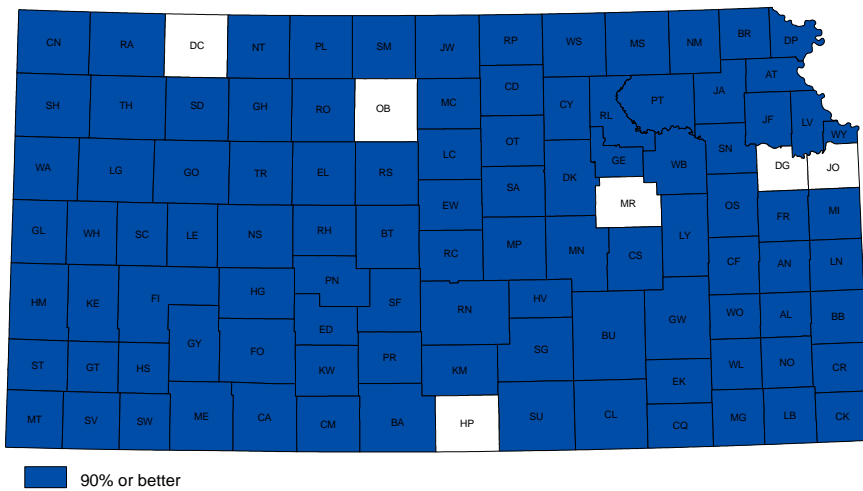
MMR1 Series for Retrospective Survey 2009-10



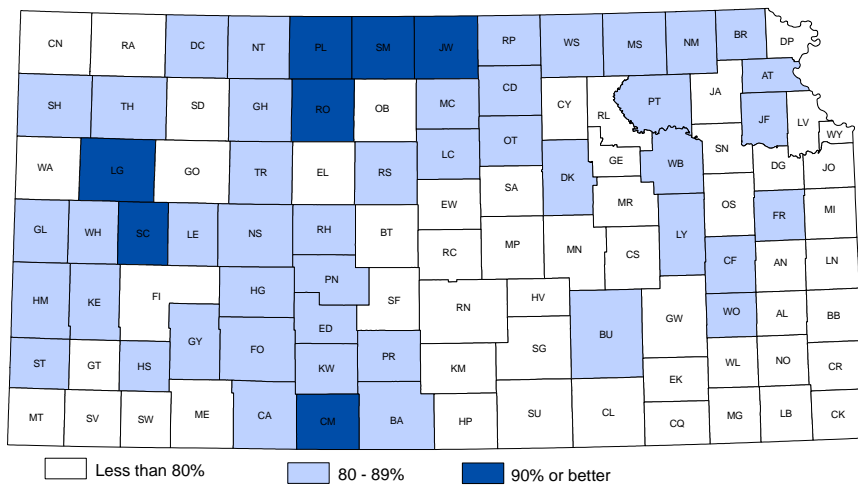
Hib3 Series for Retrospective Survey 2009-10



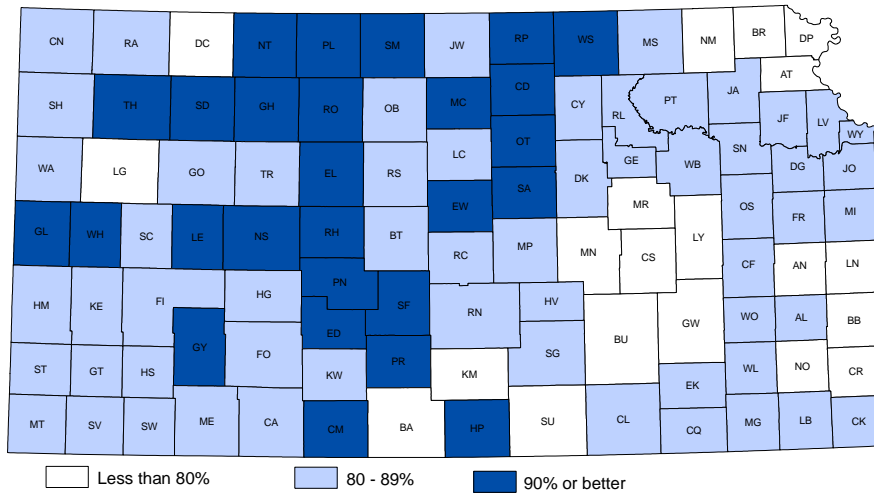
HepB3 Series for Retrospective Survey 2009-10



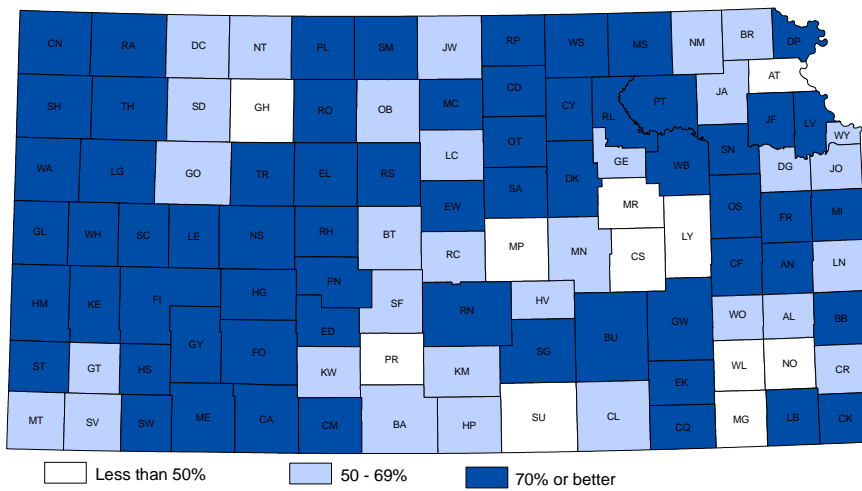
4-3-1-3-3 Series for Retrospective Survey 2009-10



Var1 Series for Retrospective Survey 2009-10



PCV3 Series for Retrospective Survey 2009-10




Note: Intervals used are different from the other maps

Appendix 4: CDC's 2004 Advisory Committee on Immunization Practices (ACIP)

Recommendations <http://www.cdc.gov/mmwr/preview/mmwrhtml/mm5301-immunizational1.htm>

FIGURE. Recommended childhood and adolescent immunization schedule¹ — United States, January–June 2004

Vaccine	Range of recommended ages				Catch-up vaccination				Preadolescent assessment			
	Birth	1 mo	2 mo	4 mo	6 mo	12 mo	15 mo	18 mo	24 mo	4–6 y	11–12 y	13–18 y
Hepatitis B ²	HepB #1	only if mother HBsAg (+)							HepB series			
		HepB #2			HepB #3							
Diphtheria, ³ Tetanus, Pertussis			DTaP	DTaP	DTaP		DTaP		DTaP	Td	Td	
<i>Haemophilus influenzae</i> type b ⁴			Hib	Hib	Hib ⁴	Hib						
Inactivated Polio			IPV	IPV	IPV				IPV			
Measles, ⁵ Mumps, Rubella						MMR #1			MMR #2		MMR #2	
Varicella ⁶						Varicella			Varicella			
Pneumococcal ⁷			PCV	PCV	PCV	PCV			PCV	PPV		
Vaccines below this line are for selected populations												
Hepatitis A ⁸									HepA series			
Influenza ⁹					Influenza (yearly)							

1. Indicates the recommended ages for routine administration of currently licensed childhood vaccines, as of December 1, 2003, for children through age 18 years. Any dose not given at the recommended age should be given at any subsequent visit when indicated and feasible.  Indicates age groups that warrant special effort to administer those vaccines not given previously. Additional vaccines may be licensed and recommended during the year. Licensed combination vaccines may be used whenever any components of the combination are indicated and the vaccine's other components are not contraindicated. Providers should consult the manufacturers' package inserts for detailed recommendations. Clinically significant adverse events that follow vaccination should be reported to the Vaccine Adverse Event Reporting System (VAERS). Guidance on how to obtain and complete a VAERS form is available at <http://www.vaers.org> or by telephone, 800-822-7967.

2. Hepatitis B vaccine (HepB). All infants should receive the first dose of HepB vaccine soon after birth and before hospital discharge; the first dose also may be given by age 2 months if the infant's mother is HBsAg-negative. Only monovalent HepB vaccine can be used for the birth dose. Monovalent or combination vaccine containing HepB may be used to complete the series; 4 doses of vaccine may be administered when a birth dose is given. The second dose should be given at least 4 weeks after the first dose except for combination vaccines, which cannot be administered before age 6 weeks. The third dose should be given at least 16 weeks after the first dose and at least 8 weeks after the second dose. The last dose in the vaccination series (third or fourth dose) should not be administered before age 24 weeks. Infants born to HBsAg-positive mothers should receive HepB vaccine and 0.5 mL hepatitis B immune globulin (HBIG) within 12 hours of birth at separate sites. The second dose is recommended at age 1–2 months. The last dose in the vaccination series should not be administered before age 24 weeks. These infants should be tested for HBsAg and anti-HBs at age 9–15 months. Infants born to mothers whose HBsAg status is unknown should receive the first dose of the HepB vaccine series within 12 hours of birth. Maternal blood should be drawn as soon as possible to determine the mother's HBsAg status; if the HBsAg test is positive, the infant should receive HBIG as soon as possible (no later than age 1 week). The second dose is recommended at age 1–2 months. The last dose in the vaccination series should not be administered before age 24 weeks.

3. Diphtheria and tetanus toxoids and acellular pertussis vaccine (DTaP). The fourth dose of DTaP may be administered at age 12 months provided that 6 months have elapsed since the third dose and the child is unlikely to return at age 15–18 months. The final dose in the series should be given at age ≥4 years. Tetanus and diphtheria toxoids (Td) is recommended at age 11–12 years if at least 5 years have elapsed since the last dose of tetanus and diphtheria toxoid-containing vaccine. Subsequent routine Td boosters are recommended every 10 years.

Additional information about vaccines, including precautions and contraindications for vaccination and vaccine shortages, is available at <http://www.cdc.gov/nip> or from the National Immunization Information hotline, telephone 800-232-2522 (English) or 800-232-0233 (Spanish). Approved by the Advisory Committee on Immunization Practices (<http://www.cdc.gov/nip/acip>), the American Academy of Pediatrics (<http://www.aap.org>), and the American Academy of Family Physicians (<http://www.aafp.org>).

4. *Haemophilus influenzae* type b (Hib) conjugate vaccine. Three Hib conjugate vaccines are licensed for infant use. If PRP-OMP (PedvaxHIB® or ComVax® [Merck]) is administered at ages 2 and 4 months, a dose at age 6 months is not required. DTaP/Hib combination products should not be used for primary vaccination in infants at ages 2, 4, or 6 months but can be used as boosters after any Hib vaccine. The final dose in the series should be given at age ≥12 months.

5. Measles, mumps, and rubella vaccine (MMR). The second dose of MMR is recommended routinely at age 4–6 years but may be administered during any visit provided that at least 4 weeks have elapsed since the first dose and that both doses are administered beginning at or after age 12 months. Those who have not received the second dose previously should complete the schedule by the visit at age 11–12 years.

6. Varicella vaccine (VAR). Varicella vaccine is recommended at any visit at or after age 12 months for susceptible children (i.e., those who lack a reliable history of chickenpox). Susceptible persons aged ≥13 years should receive 2 doses given at least 4 weeks apart.

7. Pneumococcal vaccine. The heptavalent pneumococcal conjugate vaccine (PCV) is recommended for all children aged 2–23 months and for certain children aged 24–59 months. The final dose in the series should be given at age ≥12 months. Pneumococcal polysaccharide vaccine (PPV) is recommended in addition to PCV for certain high-risk groups. See *MMWR* 2000;49(No. RR-9):1–35.

8. Hepatitis A vaccine. Hepatitis A vaccine is recommended for children and adolescents in selected states and regions, and for certain high-risk groups. Consult local public health authority and *MMWR* 1999;48(No. RR-12):1–37. Children and adolescents in these states, regions, and high-risk groups who have not been vaccinated against hepatitis A can begin the hepatitis A vaccination series during any visit. The two doses in the series should be administered at least 6 months apart.

9. Influenza vaccine. Influenza vaccine is recommended annually for children aged ≥6 months with certain risk factors (including but not limited to asthma, cardiac disease, sickle cell disease, HIV, and diabetes), and household members of persons in groups at high risk (see *MMWR* 2003;52[No. RR-8]:1–36), and can be administered to all others wishing to obtain immunity. In addition, healthy children aged 6–23 months are encouraged to receive influenza vaccine if feasible because children in this age group are at substantially increased risk for influenza-related hospitalizations. For healthy persons aged 5–49 years, the intranasally administered live-attenuated influenza vaccine (LAIV) is an acceptable alternative to the intramuscular trivalent inactivated influenza vaccine (TIV). See *MMWR* 2003;52[No. RR-13]:1–8. Children receiving TIV should be administered a dosage appropriate for their age (0.25 mL if 6–35 months or 0.5 mL if ≥3 years). Children aged ≥8 years who are receiving influenza vaccine for the first time should receive 2 doses (separated by at least 4 weeks for TIV and at least 6 weeks for LAIV).